

**STATE OF NEW MEXICO
BEFORE THE ENVIRONMENTAL IMPROVEMENT BOARD**

**IN THE MATTER OF PROPOSED REVISIONS
TO THE STATE IMPLEMENTATION PLAN
FOR REGIONAL HAZE**

No. EIB 11-01 (R)

**NMED EXHIBIT 8c
WRITTEN TESTIMONY OF MARY UHL
BART DETERMINATION FOR SAN JUAN GENERATING STATION**

1 Please describe the regulatory history of the BART Rule.

2 In 1999, the EPA published a final rule to address a type of visibility impairment known as
3 regional haze.¹ This rule requires States to submit state implementation plans (SIPs) to address
4 regional haze visibility impairment in 156 Federally-protected parks and wilderness areas. The
5 1999 rule was issued to fulfill a long-standing EPA commitment to address regional haze under
6 the authority and requirements of sections 169A and 169B of the Clean Air Act (CAA).²

7 As required by the CAA, the EPA included in the final regional haze rule a requirement for Best
8 Available Retrofit Technology (BART) for certain large stationary sources. The regulatory
9 requirements for BART were codified at 40 CFR § 50.308(e) and in definitions that appear in 40
10 CFR § 50.301.

11 The BART-eligible sources are those sources which (1) have the potential to emit 250 tons per
12 year or more of a visibility impairing air pollutant, (2) were put in place between August 7, 1962
13 and August 7, 1977, (3) and whose operations fall within one or more of 26 specifically listed
14 source categories.³ Under the CAA, BART is required for any BART-eligible source which a
15 State determines “emits any air pollutant which may reasonably be anticipated to cause or
16 contribute to any impairment of visibility in any such area.”⁴ Accordingly, for stationary sources
17 meeting these criteria, States must address the BART requirement when they develop their
18 regional haze SIPs.

19 The EPA published a second Regional Haze rulemaking on June 6, 2005⁵ that made changes to
20 the Final Rule published July 1, 1999. This second rulemaking was in response to a U.S. District

¹ 64 Fed. Reg. 35714, July 1, 1999.

² 42 U.S.C. §§ 7491 & 7492.

³ 42 U.S.C. § 7491 (g)(7).

⁴ 42 U.S.C. § 7491 (b)(2)(a).

⁵ 70 Fed. Reg. 39104, July 6, 2005.

1 Court of Appeals ruling that vacated part of the regional haze rule.⁶ The June 6, 2005 Final Rule
2 (1) required the BART analysis to include an analysis of the degree of visibility improvement
3 resulting from the use of control technology at BART-subject sources; (2) revised the BART
4 provisions; (3) included new BART Guidelines contained in a new Appendix Y to Part 51
5 (Guidelines); and (4) added the requirement that States use the Guidelines for determining
6 BART at certain large electrical generating units (EGUs).

7 The guidelines are designed to help States and others (1) identify those sources that must comply
8 with the BART requirement, and (2) determine the level of control technology that represents
9 BART for each source.

10 The Guidelines also contained specific presumptive limits for SO₂ and NO_x for certain large
11 EGUs based on fuel type, unit size, cost effectiveness, and presence or absence of pre-existing
12 controls. For NO_x emissions, the EPA directs states to generally require owners and operators to
13 meet the presumptive limits at coal-fired EGUs greater than 200 MW with a total facility-wide
14 generating capacity greater than 750 MW. The presumptive limits for NO_x are based on coal
15 type, boiler type and whether SCR or SNCR are already installed at the source.

16 **Was PNM required to perform the BART analysis in accordance with Guidelines?**

17 Yes, BART must be determined for fossil-fuel fired generating plants having a total generating
18 capacity in excess of 750 megawatts pursuant to the Guidelines.⁷ Because the San Juan
19 Generating Station is a fossil-fuel fired generating plant having a total generating capacity in
20 excess of 750 megawatts, BART must be determined in accordance with the Guidelines.

21 **How did NMED determine which sources are subject to the BART rule?**

22 Section II of the Guidelines prescribes how to identify BART-eligible sources. States are
23 required to identify those sources that satisfy the following criteria: (1) sources that fall within
24 the 26 listed source categories as listed in the CAA, (2) sources that were “in existence” on
25 August 7, 1977 but were not “in operation” before August 7, 1962, and (3) sources that have a
26 current potential to emit that is greater than 250 tons per year of any single visibility impairing
27 pollutant.

28 In May 2006, the New Mexico Environment Department, Air Quality Bureau (Department)
29 conducted an internal review of sources potentially subject to the BART rule. New Mexico
30 identified 11 sources as BART-eligible sources as part of this review.

31 The Guidelines then prescribe to the states how to identify those sources that are subject to
32 BART. At this point, states are directed to either (1) make BART determinations for all BART-
33 eligible sources, or (2) to consider exempting some of the sources from BART because they may

⁶ *American Corn Growers Association v. EPA*, 291 F.3d 1 (DC Cir. 2002).

⁷ See 40 CFR § 51.308(e)(1)(ii)(A).

not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area⁸. New Mexico opted to perform an initial screening model on each of these BART-eligible sources to determine whether each source did cause or contribute to any visibility impairment. The Guidelines direct States that if the analysis shows that an individual source or group of sources is not reasonably anticipated to cause or contribute to any visibility impairment in a Class I area, then the States do not need to make a BART determination for that source or group of sources.

The Western Regional Air Partnership (WRAP) performed the initial BART modeling for the state of New Mexico.

The basic assumptions in the WRAP BART CALMET/CALPUFF modeling used for New Mexico are as follows:

- i. Use of three years of modeling of 2001, 2002, and 2003.
- ii. Visibility impacts due to emissions of SO₂, NO_x and primary PM emissions were calculated. PM emissions were modeled as PM_{2.5}.
- iii. Visibility was calculated using the Original Interagency Monitoring of Protected Visual Environments (IMPROVE) equation and Annual Average Natural Conditions.

Initial modeling was performed for the 11 source complexes in New Mexico to estimate visibility impacts from the sources' SO₂, NO_x, and PM emissions. Then for those sources whose 98th percentile visibility impacts at any Class I area due to their combined SO₂, NO_x, and PM emissions exceeded the 0.5 dv significance threshold, the separate contribution to visibility at Class I areas was assessed for SO₂ alone (modeled as SO₄), NO_x alone (modeled as NO₃), PM alone (modeled as PMF) and combined NO_x plus PM emissions (modeled as NO₃ + PMF).

Of the 11 source complexes analyzed, only one source complex's visibility impacts at any Class I area due to combined SO₂, NO_x, and PM emissions exceeded the 0.5 dv threshold (PNM San Juan Generating Station Boilers #1-4). Of the 10 other source complexes, none exceed a 0.33 dv impact. Consequently, only the PNM San Juan Boilers #1-4 were subject to the additional analysis of determining the pollutant-specific contribution...

On November 9, 2006, the Department informed PNM that the modeling performed by the WRAP indicated the visibility impairment from the San Juan Generating Station (SJGS) was over the 0.5 dv threshold, and was therefore subject to a BART analysis. In response, Black & Veatch (B&V), on behalf of PNM, submitted the BART Modeling Protocol document which described the CALPUFF modeling methodology to be used as part of the BART engineering evaluation for Units 1-4 at the SJGS.

When did PNM submit the BART analysis for the SJGS?

⁸ See 70 Fed. Reg. at 39161.

1 PNM submitted the BART analysis for the SJGS to the Department on June 6, 2007.

2 **How was the BART analysis structured?**

3 The BART analysis was performed in two stages. First, a BART analysis was performed for the
4 consent decree technologies being implemented at the SJGS. On March 5, 2005, PNM entered
5 into a consent decree with the Grand Canyon Trust, the Sierra Club, and the Department to settle
6 alleged violations of the CAA.⁹ The consent decree required PNM to meet a PM average
7 emission rate of 0.015 pounds per million British thermal units (lb/MMbtu) (measured using
8 EPA Reference Method 5), and a 0.30 lb/MMbtu emission rate for NOx (daily rolling, thirty day
9 average), for each of Units 1, 2, 3, and 4. As a result, PNM has installed new Low NOx burners
10 (LNB) with overfire air (OFA) ports and a neural network (NN) system to reduce NOx
11 emissions, and pulse jet fabric filters (PJFF) to reduce the PM emissions

12 In the second stage of the BART analysis, additional control technology alternatives to the
13 consent decree technologies were identified and evaluated. To determine the visibility
14 improvements from both the consent decree technology upgrades and additional control
15 technology, the Department determined it was appropriate to review both pre-consent decree to
16 consent decree visibility improvement and improvement projected from consent decree plus
17 additional control technologies.

18 **Did PNM follow the 5 Step process in their preparation of the BART analysis?**

19 Yes, PNM followed the 5 Step Process in the SJGS BART Analysis.

20 **What are the five steps?**

21 The five steps are¹⁰:

- 22 Step 1 – Identify All Available Retrofit Control Technologies
- 23 Step 2 – Eliminate Technically Infeasible Options
- 24 Step 3 – Evaluate Control Effectiveness of Remaining Control Technologies
- 25 Step 4 – Evaluate Impacts and Document the Results
 - 26 a) Costs of Compliance
 - 27 b) Energy Impacts
 - 28 c) Air quality environmental impacts
 - 29 d) Non-air environmental impacts
 - 30 e) Remaining useful life
- 31 Step 5 – Evaluate Visibility Impacts

32 **Did PNM submit updates to the original BART analysis?**

⁹ *Grand Canyon Trust v. Pub. Serv. Co. of New Mexico*, No. CV 02-552 BB/ACT (ACE), (D. N.M. 2005)

¹⁰ See 70 Fed. Reg. at 39164.

1 Yes, PNM submitted multiple updates to the original analysis.

2 **Would you provide an overview of each of those additional submittals?**

3 On November 6, 2007, PNM submitted additional modeling analyses to provide SJGS plant-
4 wide regional haze visibility impacts at 16 Class I areas. The analysis was based on refinements
5 which included using the nitrate repartitioning methodology and monthly variable background
6 ammonia concentrations. The NOx control technologies analyzed were the SCR and
7 SNCR/SCR Hybrid.

8 On March 29, 2008, PNM submitted an additional discussion of cost estimation methods used to
9 determine costs of SCR installation and a discussion of Nalco Mobotec ROFA and Rotamix
10 technology.

11 On March 31, 2008, PNM submitted two additional modeling analyses to provide SJGS plant-
12 wide and unit specific regional haze visibility impacts at 16 Class I areas for the SCR NOx
13 control technology only. One of the analyses, believed by PNM to be the more representative of
14 ammonia chemistry of the area, was based on the November 6, 2007 refinements which included
15 using nitrate repartitioning methodology and monthly variable background ammonia
16 concentrations. The other analysis included nitrate repartitioning and a constant background
17 ammonia concentration as requested by the Department.

18 On May 30, 2008, PNM submitted two additional modeling analyses to provide SJGS plant-wide
19 and unit specific regional haze visibility impacts at 16 Class I areas for the SNCR NOx control
20 technology only. Similar to the March 31, 2008 analyses, one of the analyses was based on the
21 November 6, 2007 refinements which included using nitrate repartitioning methodology and
22 monthly variable background ammonia concentrations. The other analysis used nitrate
23 repartitioning methodology and constant background ammonia concentration. It should be noted
24 that PNM modeled all variants of SNCR together (including Fuel Tech and Nalco Mobotec) as
25 one technology called SNCR. This is the same approach that is used for modeling SCR control
26 technology, where all variants are modeled generically as SCR.

27 At the request of the Department, PNM and B&V also provided a five-factor BART analysis for
28 SNCR technology and a discussion of coal characteristics of the coal burned at the SJGS.

29 On August 29, 2008, PNM submitted three additional modeling analyses to provide SJGS plant-
30 wide and unit specific regional haze visibility impacts at 16 Class I areas for the ROFA with
31 Rotamix, Rotamix, ROFA, and WESP PM control technologies (the NOx and PM analyses were
32 submitted separately). Similar to the May 30, 2008 analyses, these analyses were also based on
33 the November 6, 2007 refinements which included using the nitrate repartitioning methodology
34 and monthly variable background ammonia concentrations.

At the request of the Department, PNM and B&V also provided a five-factor BART analysis of Nalco Mobotec control technology, including ROFA, Rotamix and ROFA/Rotamix and a five-factor BART analysis of additional PM control technology.

On March 16, 2009, PNM submitted four additional modeling analyses to provide SJGS plant-wide and unit specific regional haze visibility impacts at 16 Class I areas. These include SCR technology, SCR/SNCR Hybrid technology; SCR technology with sorbent injection; and SCR/SNCR Hybrid technology with sorbent injection. As requested by the Department, for each of these cases, the modeling also took into consideration inherent SO₃ removal of the SO₃ formed from the catalyst oxidation of SO₂ to SO₃.

On February 15, 2011, PNM submitted a revised analysis of SNCR technology after PNM received a lower vendor-guaranteed emission rate from Fuel Tech, a vendor of SNCR technology. The analysis also included updated cost estimates for SCR, SNCR/SCR Hybrid, ROFA/Rotamix, Rotamix (SNCR), ROFA, and SNCR (Fuel Tech) technologies. The Department did not review the updated cost analyses for these control technologies and does not necessarily agree with the new cost-estimates supplied in the analysis.

The February 2011 submittal further included a ratepayer impact analysis which estimated the cost impact to residential ratepayers from installation of SNCR and SCR technologies.

One modeling analysis was performed to provide SJGS plant-wide and unit specific regional haze visibility impacts at 16 Class I areas assuming the revised SNCR control technology on all four units.

Did PNM include all Available Retrofit Emissions Control Technologies in Step 1 of the BART analysis?

Yes, the Department found that PNM included a complete list of all available control technologies.

What are the strategies for reducing NO_x and PM emissions from power plants?

The main strategies for reducing NO_x emissions take two forms: 1) modification to the combustion process to control fuel and air mixing and reduce flame temperatures, and 2) post-combustion treatment of the flue gas to remove NO_x.

Particulate matter emissions can only be controlled by post-combustion control technologies.

What specific control technologies did PNM include in Step 1?

- 1) Low NO_x Burners, Overfire Air, and Neural Network
Low NO_x burners slow and control the rate of fuel and air mixing, thereby reducing the oxygen availability in the ignition and main combustion zones. Overfire Air uses low excess air levels in the primary combustion zone with the remaining (overfire) air added

higher in the furnace to complete combustion. Neural Network provides improvements in the heat rate and reduce combustion-related emissions by fine-tuning the combustion process.

2) Selective Non Catalytic Reduction (SNCR)

SNCR is based on the chemical reduction of the NO molecule into molecular nitrogen and water vapor. A nitrogen based reducing agent (reagent), such as ammonia or urea, is injected into the post combustion flue gas. The reduction with NO is favored over other chemical reaction processes at temperatures ranging between 1600F and 2100F (870C to 1150C), therefore, it is considered a selective chemical process.

3) Selective Catalytic Reduction (SCR)

The SCR process chemically reduces the NO molecule into molecular nitrogen and water vapor in the presence of a reducing catalyst. A nitrogen based reducing reagent such as ammonia or urea is injected into the ductwork, downstream of the combustion unit. The waste gas mixes with the reagent and enters a reactor module containing catalyst. The hot flue gas and reagent diffuse through the catalyst. The reagent reacts selectively with the NO within a specific temperature range and in the presence of the catalyst and excess oxygen.

SCR plus Sorbent Injection

Sorbent injection removes SO₃ in the flue gas by reaction of the SO₃ with an alkaline sorbent material to form a particulate that is subsequently removed in a particulate control device. The alkaline material injected can be a magnesium, sodium, or calcium-based sorbent. The injection points for the reagents may vary. For this analysis, hydrated lime was selected.

4) SNCR/SCR Hybrid

The SNCR/SCR hybrid systems use components and operating characteristics of both SNCR and SCR systems. Hybrid systems were developed to combine the low capital cost and high ammonia slip associated with SNCR systems with the high reduction potential and low ammonia slip inherent in the catalyst of SCR systems.

SNCR/SCR Hybrid plus Sorbent Injection

Sorbent injection removes SO₃ in the flue gas by reaction of the SO₃ with an alkaline sorbent material to form a particulate that is subsequently removed in a particulate control device. The alkaline material injected can be a magnesium, sodium, or calcium-based sorbent. The injection points for the reagents may vary. For this analysis, hydrated lime was selected.

5) Gas Reburn

The gas reburn process combusts auxiliary natural gas, along with coal, in the boiler.

Three separate combustion zones in the boiler are manipulated to reduce NO_x emissions.

6) Nalco Mobotec ROFA and Rotamix

ROFA and Rotamix are proprietary control technologies developed by Nalco Mobotec. ROFA, or Rotating Opposed Firing Air, is a modified overfire air technology that utilizes rotation of flue gases and turbulent mixing to reduce NO_x emissions. Rotamix is a version of SNCR technology and operates under the same principles as other SNCR technology.

7) NO_xStar

NO_xStar is the trademarked name for a NO_x control technology that involves the injection of ammonia and a hydrocarbon (typically natural gas) into the flue gas path of a coal-fired boiler at around 1600F to 1800F for the reduction of NO_x.

8) ECOTUBE

The ECOTUBE system utilizes retractable lance tubes that penetrate the boiler above the primary combustion burner zone and inject high-velocity air as well as reagents. The lance tubes work to create turbulent airflow and to increase the residence time for the air/fuel mixture. In principle, the OFA and SNCR processes are combined in this technology.

9) PowerSpan ECO

The PowerSpan ECO system is a multi-pollutant technology with limited experience. The PowerSpan 5ECO system is located downstream of an existing particulate control device and treats the power plant's flue gas in three process steps to achieve multi-pollutant removal of sulfur dioxide (SO₂), nitrogen oxides (NO_x), oxidized mercury, and fine particulate matter.

10) Phenix Clean Combustion

Phenix Clean Combustion System is an advanced hybrid coal gasification/combustion process that prevents the formation of NO_x and SO₂ emissions when burning coal.

11) e-SCRUB

The e-SCRUB process is similar to the PowerSpan technology in that it uses an energy source to oxidize pollutants in the flue gas. However, there are some variations in the oxidation energy source and the byproduct recovery systems.

PM Control Technologies

1) Flue Gas Conditioning with Hot-Side ESP

Flue gas conditioning improves the collection efficiency of particulate matter in the ESP. Flue gas leaving the air heater into the ESP can be conditioned by addition of ionic compounds, such as SO₃ or ammonia. These compounds combine with the moisture in the flue gas and are deposited on the surface of the fly ash particles. This will increase the conductivity of the fly ash and make it more suitable for capture.

1 2) Pulse Jet Fabric Filter (PJFF)

2 In PJFFs, the flue gas typically enters the compartment hopper and passes from the
3 outside of the bag to the inside of the bag, depositing particulate on the outside of the
4 bag. To prevent collapse of the bag, a metal cage is installed on the inside of the bag.
5 The flue gas passes up through the center of the bag into the output plenum. Cleaning is
6 performed by initiating a downward pulse of air into the top of the bag. The pulse causes
7 a ripple effect along the length of the bag. This releases the dust cake from the bag's
8 exterior surface, allowing the dust to fall into the hopper.

9 3) Compact Hybrid Particulate Collector

10 A variant of the PJFF is the compact hybrid particulate collector. This is a high air to
11 cloth (A/C) ratio fabric filter installed downstream of existing particulate collection
12 devices where the majority of PM has been removed.

13 4) Max-9 Electrostatic Fabric Filter

14 The Max-9 filter is essentially a high-efficiency PJFF utilizing a discharge electrode as in
15 an ESP. However, there are no collector plates. When the dust particles are charged, they
16 are attracted to the grounded metal cage inside the filter element, just as they would be
17 attracted to the collecting plates in an ordinary precipitator.

18 During the Department review of available PM control technologies, the Department requested
19 PNM to perform a complete five-factor BART analysis on Wet Electrostatic Precipitator
20 (WESP). The Department believes this technology should have been identified as technically
21 feasible in Step 1 of the PM BART analysis. PNM performed a complete five-factor BART
22 analysis on WESP and PJFF and submitted report in a subsequent submittal dated August 28,
23 2008.

24 **Did PNM Propose to Eliminate any Control Technologies as Technically Infeasible In Step**
25 **2 of the BART Analysis?**

26 Yes, PNM excluded several of the identified NO_x and PM controls due to technical infeasibility.

27 **Which specific technologies did PNM Propose to Eliminate?**

28 1) Selective Non Catalytic Reduction

29 PNM determined in its submittal of June 6, 2007 that SNCR technology was technically
30 infeasible because the technology was unable to meet the presumptive limits for NO_x;
31 determined by EPA to be 0.23 lb NO_x/MMbtu for dry bottom, wall-fired boilers burning
32 sub-bituminous coal. A vendor estimated that the technology could only achieve 0.24 lb
33 NO_x/MMbtu. In order for the technology to achieve the presumptive limit, PNM stated
34 that ammonia slip limit would need to be raised from 5 ppm to 10 ppm, and that this
35 higher ammonia slip posed additional operational problems.

1 The Department did not agree with PNM's assertion that because SNCR could not meet the
2 presumptive limits the technology should be eliminated as technically infeasible. Therefore the
3 Department requested PNM to perform the complete 5-factor BART analysis required by the
4 Guidelines on SNCR. PNM submitted the five-factor analysis of SNCR in a subsequent
5 submittal dated May 30, 2008 and an updated analysis of Fuel Tech's SNCR on February 11,
6 2011.

7 2) Natural Gas Reburn

8 PNM determined that the current boiler space inhibits sufficient residence time for the
9 natural gas reburn zone. The Department accepts PNM's elimination of this technology
10 due to space limitations.

11 3) NalcoMobotec ROFA and Rotamix

12 PNM determined the Rotamix technology was technically infeasible due to limited
13 application at coal-fired boilers equivalent to the size of Units 1-4 at SJGS. PNM
14 determined ROFA technology was technically infeasible because ROFA is a variant of
15 OFA, which at the time was being installed at Units 1-4 at SJGS.

16 The Department did not agree with PNM's position that Rotamix has limited application at coal-
17 fired boilers equivalent the size of Units 1-4 at SJGS. The Department did not agree that because
18 ROFA is a variant of OFA, the technology can be eliminated as technically infeasible. Therefore
19 the Department requested PNM perform the complete 5-factor analysis for ROFA and Rotamix.
20 PNM performed the analyses and submitted them in two subsequent submittals dated March 29,
21 2008 and August 29, 2008.

22 4) NOxStar

23 NOxStar currently has only one major installation in the US. In addition, PNM stated
24 that in recent discussions the supplier has identified limited ability and willingness to
25 market the commercial technology. The Department agrees that this technology has
26 limited application to large coal-fired boilers and is not technically feasible.

27 5) ECOTUBE

28 The ECOTUBE technology has been demonstrated on industrial/small boilers firing sold
29 waste, wood, and biomass.³ ECOTUBE has limited application to boilers similar to Units
30 1-4 at the SJGS. The Department agrees that this technology has limited application to
31 large coal-fired boilers and is not technically feasible.

32 6) PowerSpan

33 PowerSpan has not been demonstrated on large boilers, such as Units 1-4 at SJGS. The
34 Department agrees that this technology has limited application to large coal-fired boilers
35 and is not technically feasible.

36 7) Phenix Clean Combustion

PNM determined that the Phenix Clean Combustion system is still in the demonstration and testing stage, and there are no commercial retrofits at facilities similar to SJGS. The Department agrees that this technology has no demonstrated application to the source type and is not technically feasible.

8) e-SCRUB

PNM determined that the e-SCRUB technology has only one known medium scale installation with limited data. The Department agrees that the technology should be considered technically infeasible due to limited demonstrated applications.

PNM excluded the following PM control technologies as technically infeasible:

1) Flue Gas Conditioning with Hot-Side ESP

Flue gas conditioning does improve collection efficiencies, but will not achieve an emission limit lower than the current PM limit in their air quality permit. The Department agrees that flue gas conditioning control technology should not be considered in the BART analysis. Because the vendor was unable to guarantee a lower emission rate, the technology does not need to undergo the three additional factors of the five factor analysis.

2) Compact Hybrid Particulate Collector

The compact hybrid particulate collector does not provide a performance guarantee lower than the current permitted limit for PM. The Department agrees that the compact hybrid PM control technology should not be considered in the BART analysis. Because the vendor was unable to guarantee a lower emission rate, the technology does not need to undergo the three additional factors of the five factor analysis.

3) Max-9 Electrostatic Fabric Filter

The Max-9 electrostatic fabric filter has been installed in a small-sized utility boiler, but there are no commercial installations of a similar size to Units 1-4 at SJGS. The Department agrees that the limited application of this technology to large utility boilers justifies removing the technology as technically infeasible.

Please explain Step 3 of the BART Analysis.

Step 3 of the BART analysis requires evaluating the control effectiveness of each remaining technically feasible control technology identified in Step 2.

PNM contracted with B&V to determine the control effectiveness of the remaining available NO_x and PM control technology, with exception of the ROFA/Rotamix technology, for Units 1-4.

PNM requested the control effectiveness of the ROFA/Rotamix technologies from Nalco Mobotec, the vendor of the control equipment.

1 PNM then ranked the remaining control technologies by effectiveness of control.

2 **NO_x** Control Effectiveness for Unit 1

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.43	5394
CD	23	5394	1254	0.30	4140
ROFA	13	4140	552	0.26	3588
Rotamix (SNCR)	23	4140	966	0.23	3174
SNCR	23	4140	966	0.23	3174
ROFA/Rotamix	33	4140	1380	0.20	2760
SCR/SNCR Hybrid	40	4140	1656	0.18	2484
SCR + Sorbent	77	4140	3174	0.07	966

3 **NO_x** Control Effectiveness for Unit 2

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.45	6179
CD	33	6179	2060	0.30	4119
ROFA	13	4119	549	0.26	3570
Rotamix (SNCR)	23	4119	961	0.23	3158
SNCR	23	4119	961	0.23	3158
ROFA/Rotamix	33	4119	1373	0.20	2746
SCR/SNCR Hybrid	40	4119	1648	0.18	2471
SCR + Sorbent	77	4119	3158	0.07	961

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1 **NO_x Control Effectiveness for Unit 3**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMBtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.42	9004
CD	29	9004	2573	0.30	6431
ROFA	13	6431	857	0.26	5574
Rotamix (SNCR)	23	6431	1500	0.23	4931
SNCR	23	6431	1500	0.23	4931
ROFA/Rotamix	33	6431	2144	0.20	4287
SCR/SNCR Hybrid	40	6431	2572	0.18	3859
SCR + Sorbent	77	6431	4930	0.07	1501

2 **NO_x Control Effectiveness for Unit 4**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMBtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.42	8833
CD	29	8833	2524	0.30	6309
ROFA	15	6309	841	0.26	5468
Rotamix (SNCR)	23	6309	1472	0.23	4837
SNCR	23	6309	1472	0.23	4837
ROFA/Rotamix	33	6309	2103	0.20	4206
SCR/SNCR Hybrid	40	6309	2524	0.18	3786
SCR + Sorbent	77	6309	4837	0.07	1472

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1 **PM Control Effectiveness for Unit 1**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.050	690
PJFF (CD)	70	690	483	0.015	207
WESP	33	207	69	0.010	138

2 **PM Control Effectiveness for Unit 2**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.050	687
PJFF (CD)	70	687	481	0.015	206
WESP	33	206	69	0.010	137

3 **PM Control Effectiveness for Unit 3**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.050	1072
PJFF (CD)	70	1072	750	0.015	322
WESP	33	322	108	0.010	214

4 **PM Control Effectiveness for Unit 4**

Control Technology	Control Efficiency (%)	Baseline Emissions (tpy)	Emissions Reduction (tpy)	Controlled Emission Rate (lb/MMbtu)	Controlled Emission Rate (tpy)
Pre-Consent Decree (Pre-CD)	NA	NA	NA	0.050	1052
PJFF (CD)	70	1052	737	0.015	315
WESP	33	315	105	0.010	210

5

1 **Please explain Step 4 of BART Analysis.**

2 Step 4 requires an impacts analysis of each technology identified in Step 3.

3 The Guidelines require states to consider four types of impact analysis in Step 4 of the BART
4 analysis. These four types of impacts consider the costs of compliance, energy impacts, non-air
5 quality environmental impacts, and remaining useful life of the facility.¹¹ These impacts are
6 each evaluated, monetized, and included in the total capital investment of each additional control
7 technology and allow comparisons to be made between the remaining controls. B&V performed
8 an impact analysis for the remaining NOx and PM control technologies.

9 B&V prepared the design parameters and developed estimates of capital and annual costs for
10 applications of SCR, SCR/SNCR Hybrid, ROFA, Rotamix, ROFA/Rotamix, PJFF, and WESP
11 technologies. B&V relied on a number of sources to prepare the design parameters, including
12 information from the Nalco Mobotec equipment vendors, EPA cost manuals, engineering and
13 performance data, and B&V's own in-house engineering estimates.

14 PNM evaluated the energy impacts, non-air quality environmental impacts, and remaining useful
15 life of all additional technically feasible control options for NOx and PM. Energy impacts from
16 control equipment that consume auxiliary power during operation were considered for all control
17 options. For SCR and SCR/SNCR Hybrid technology, the non-air quality environmental impacts
18 included the consideration of water usage and waste generated from each control technology.
19 For WESP technology, PNM considered the auxiliary power consumption to operate the WESP
20 and fans, and the additional water consumption and waste water disposal requirements from
21 operating the WESP. Lastly, PNM evaluated the remaining useful life of the source. The
22 Guidelines define the remaining useful life as the difference between the date the controls will be
23 put in place and the date the facility permanently stops operation. Per the Guidelines, if the
24 remaining useful life will exceed the amortization period of the capital investment loan, no
25 additional consideration of a short remaining useful life need to be analyzed. PNM determined
26 the remaining useful life was greater than the assumed amortization period of the loan, defined as
27 20 years, therefore, no additional cost adjustments for a short remaining useful life were
28 considered.

29 Following the initial submittal, the Department made additional requests for information on the
30 impact analysis for SCR, SNCR, ROFA, Rotamix and WESP, and for further consideration of
31 inherent and additional control of SO3 from both the SCR and SCR/SNCR Hybrid technology.

32 The Department reviewed the original cost analysis for SCR technology and subsequently
33 requested PNM to provide additional information on the basis of their cost analysis of SCR
34 technology. In response to the request, B&V provided additional clarification for the cost
35 analysis for SCR technology and submitted it to the Department on March 29, 2008. The

¹¹ See 70 Fed. Reg. at 39166.

1 submittal discussed how the OAQPS cost control manual is an insufficient method for
 2 determining actual costs of retrofitting the SJGS with SCR and provided a comparison between
 3 cost estimation based on the OAQPS manual and the B&V provided estimate.

4 PNM's initial analysis of SCR and SCR/SNCR technology took into consideration additional
 5 oxidation of SO₂ to SO₃ across the SCR catalyst bed. The Department requested PNM to
 6 consider inherent removal of SO₃ emissions from existing air pollution control equipment, and
 7 removal of SO₃ emissions through installation of sorbent injection. PNM responded with an
 8 amended submittal addressing both inherent and add-on removal of SO₃. PNM's submittal
 9 provided cost estimates of the sorbent injection system and updated visibility modeling for both
 10 SCR and SCR/SNCR Hybrid technologies.

11 The Department understands that there are SCR catalysts now on the market that are capable of a
 12 much smaller SO₂ to SO₃ conversion (around 0.5%) as opposed to the assumed 1%. The
 13 Department believes use of such a catalyst will minimize SO₃ oxidation to less than what was
 14 represented in PNM's analysis.

15 PNM provided additional impact analyses of SNCR, WESP, ROFA, and Rotamix technologies
 16 and submitted those updates to the Department.

17 The final impact analysis for the technologies evaluated, as contained in PNM's submission of
 18 February 2011, is summarized in the two Tables below:

Impact Analysis and Cost Effectiveness of Additional NO_x Control Technologies

Control Technology	Emission Performance Level (lb/MM btu)	Expected Emission Rate (tpy)	Expected Emission Reduction (tpy)	Total Capital Investment (TCI) (1,000\$)	Total Annualized Cost (TAC) (1,000\$)	Cost Effectiveness (\$/ton)	Incremental Cost Effectiveness (\$/ton)	Energy Impacts (1,000\$)	Non-Air Impacts (1,000\$)
Unit 1									
SCR + sorbent	0.07	966	3,174	192,070	21,998	6,931	3,815	1,496	NA ¹
SNCR/SCR Hybrid	0.18	2,484	1,656	110,683	16,816	10,154	35,917	706	1,762
ROFA/Rotamix	0.20	2,760	1,380	30,790	6,902	5,001	7,982	1,413	3
Rotamix (SNCR)	0.23	3,174	966	11,822	3,597	3,723	116	51	4
SNCR	0.23	3174	966	17,048	3,582	3,708	80	36	NA ¹

ROFA	0.26	3,588	552	19,256	3,549	6,429	--	1,363	NA ¹
Consent Decree	0.30	4,140	1,254	14,580	1,422	1,134	NA	NA ¹	NA ¹
Pre-CD	0.43	5,394	NA	NA	NA	NA	NA	NA	NA ¹
Unit 2									
SCR + sorbent	0.07	961	3,158	206,717	23,364	7,398	4,431	1,565	NA ¹
SNCR/SC R Hybrid	0.18	2,471	1,648	115,151	17,306	10,503	37,887	346	1,762
ROFA/Ro tamix	0.20	2,746	1,373	30,790	6,902	5,027	8,024	1,413	3
Rotamix (SNCR)	0.23	3,158	961	11,822	3,597	3,742	117	51	4
SNCR	0.23	3,158	961	17,048	3,582	3,727	80	36	NA ¹
ROFA	0.26	3,570	549	19,256	3,549	6,462	--	1,363	NA ¹
Consent Decree	0.30	4,119	2,060	14,126	1,378	669	NA	NA ¹	NA ¹
Pre-CD	0.45	6,179	NA	NA	NA	NA	NA	NA	NA ¹
Unit 3									
SCR + sorbent	0.07	1,501	4,931	260,622	30,527	6,191	2,086	2,267	NA ¹
SNCR/SC R Hybrid	0.18	3,859	2,572	178,759	26,604	10,342	39,171	507	2,658
ROFA/Ro tamix	0.20	4,287	2,144	35,724	9,810	4,576	7,498	2,810	5
Rotamix (SNCR)	0.23	4,931	1,501	13,919	4,988	3,324	-378	84	5
SNCR	0.23	4,931	1,501	21,220	4,859	3,238	-578	36	NA ¹
ROFA	0.26	5,574	857	22,081	5,231	6,100	--	2,725	NA ¹
Consent Decree	0.30	6,431	2,573	12,715	1,240	482	NA	NA ¹	NA ¹
Pre-CD	0.42	9,004	NA	NA	NA	NA	NA	NA	NA ¹
Unit 4									
SCR + sorbent	0.07	1,472	4,837	242,295	28,760	5,946	1,691	2,288	NA ¹
SNCR/SC R Hybrid	0.18	3,786	2,524	171,412	25,808	10,226	38,034	507	2,658
ROFA/Ro tamix	0.20	4,206	2,103	35,724	9,810	4,664	7,643	2,810	5

Rotamix (SNCR)	0.23	4,837	1,472	13,919	4,988	3,388	-385	84	5
SNCR	0.23	4,837	1,472	21,220	4,859	3,301	-590	36	NA ¹
ROFA	0.26	5,468	841	22,081	5,231	6,218	--	2,725	NA ¹
Consent Decree	0.30	6,309	2,524	12,870	1,256	498	NA	NA ¹	NA ¹
Pre-CD	0.42	8,833	NA	NA	NA	NA	NA	NA	NA ¹

¹ PNM performed an impact analysis for these technologies and incorporated any monetized energy or non-air environmental impacts into the cost analysis.

3 Impact Analysis and Cost Effectiveness of Additional PM Control Technologies

Control Technology	Emission Performance Level (lb/MM btu)	Expected Emission Rate (tpy)	Expected Emission Reduction (tpy)	Total Capital Investment (TCI) (1,000\$)	Total Annualized Cost (TAC) (1,000\$)	Incremental Cost Effectiveness (\$/ton)	Cost Effectiveness (\$/ton)	Energy Impacts (1,000\$)	Non-Air Impacts (1,000\$)
Unit 1									
WESP	0.010	138	69	99,308	11,855	20,696	171,812	1,112	NA ¹
PJFF (CD)	0.015	207	483	67,072	10,427	NA	21,588	4,488	NA ¹
Pre-CD	0.050	690	NA	NA	NA	NA	NA	NA	NA
Unit 2									
WESP	0.010	137	70	99,663	11,895	16,157	169,929	1,112	NA ¹
PJFF (CD)	0.015	207	480	69,840	10,764	NA	22,425	4,488	NA ¹
Pre-CD	0.050	687	NA	NA	NA	NA	NA	NA	NA
Unit 3									
WESP	0.010	214	108	129,565	15,558	28,741	144,056	1,728	NA ¹
PJFF (CD)	0.015	322	750	72,696	12,454	NA	16,605	6,895	NA ¹
Pre-CD	0.050	1072	NA	NA	NA	NA	NA	NA	NA
Unit 4									
WESP	0.010	210	105	130,012	15,609	29,352	148,657	1,728	NA ¹
PJFF (CD)	0.015	315	737	73,328	12,527	NA	16,997	6,895	NA ¹
Pre-CD	0.050	1052	NA	NA	NA	NA	NA	NA	NA

4

5

1 **Please explain Step 5 of the BART Analysis**

2 The Guidelines require states to conduct a visibility improvement determination for the each
3 source subject to BART. The visibility improvement was determined using the computer
4 program CALPUFF.

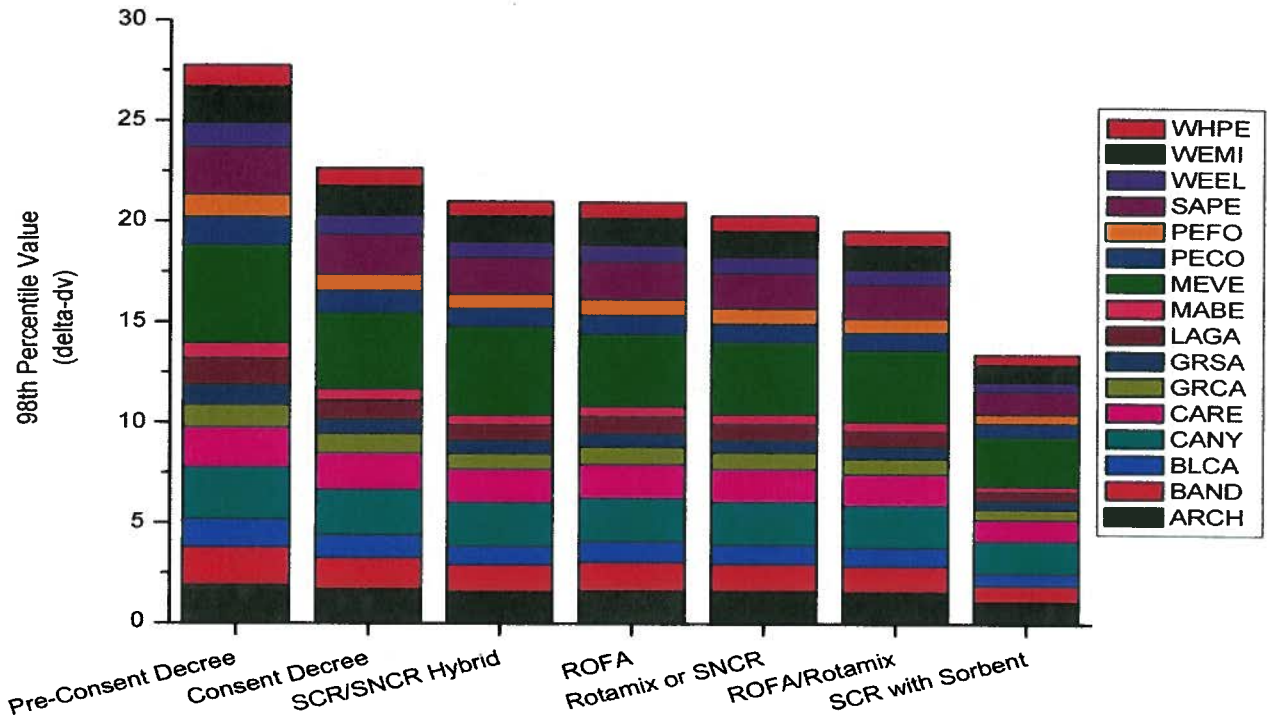
5 CALPUFF is computer-based dispersion model listed in the US EPA Guidelines on modeling.¹²
6 This model is used for regulatory applications such as air quality permitting and analysis of the
7 effects of varying levels of air pollution control for regulation development. It is the best EPA-
8 approved model for analysis of long range transport of pollutants. The CALPUFF model is a
9 complex model that incorporates chemical transformation calculations, the deposition of
10 pollutants that occurs as pollution is emitted, and the effects of existing relative humidity on
11 visibility. As input, the model requires ozone data, ammonia background concentrations,
12 speciated emissions data, and complex meteorological data, including three-dimensional wind
13 fields. The model outputs predicted impacts to visibility as well as the impact of air pollutants.

14 A CALPUFF model run was conducted for the following control technologies for each unit
15 during the BART engineering analysis, including the pre-consent decree: Consent Decree,
16 SNCR or Rotamix, ROFA/Rotamix, ROFA,, SCR/SNCR Hybrid (SCR/SNCR Hybrid with
17 Inherent SO₃ Removal), SCR with Sorbent (SCR with Inherent SO₃ Removal and Sorbent
18 Injection), PJFF, and WESP.

19 For both the facility-wide and unit-by-unit modeling analysis conducted with the 2001-2003
20 years of meteorological data, the expected degree of visibility impact for each control technology
21 was determined by the difference between the visibility impaired by the facility sources and
22 annual average natural visibility conditions for each receptor at each of the 16 Class I area which
23 is indicative of delta-deciview (delta-dv) The modeling results showed that for each additional
24 control technology the source exhibited a decrease in the visibility impacts.

¹² See 70 Fed. Reg. at 39170.

- 1 Total Amount of the Visibility Impacts at All 16 Class I Areas Using 2001-2003 Meteorological
- 2 Data (facility-wide impact)



3

4

5 How did the NMED select BART for SJGS?

6 In accordance with Section 169A(g)(7) of the Clean Air Act, the Department considered the
 7 following five statutory factors in the BART analysis for the SJGS: (1) the costs of compliance;
 8 (2) energy and non-air quality environmental impacts of compliance; (3) any existing pollution
 9 control technology in use at the source; (4) the remaining useful life of the source; and (5) the
 10 degree of improvement in visibility which may reasonably be anticipated to result from the use
 11 of such technology.

12 What did NMED determine as BART for PM at SJGS?

13 Based on the five factor analysis, the Department has determined that BART for Units 1-4 for
 14 PM is existing PJFF technology and the existing emission rate of 0.015 lb/MMbtu. The
 15 Department's determination of BART was based on the following results of the full five factor
 16 analysis:

- 17 1) Each of Units 1-4 is equipped with PJFF and is subject to a federally-enforceable emission
- 18 limit of 0.015 lb PM/MMbtu.

- 2) The Department reviewed both the cost-effectiveness and incremental cost-effectiveness of additional control technology (WESP) and found these costs to be excessive.
- 3) There are additional energy impacts associated with the WESP technology and the Department considers these costs to be reasonable.
- 4) The Department reviewed the visibility improvement that resulted from the installation of the consent decree technology (PJFF and LNB/OFA) and that would result from the addition of WESP technology. The Department determined that on a facility-wide basis the visibility improved by 1.06 deciviews (dv) from the installation of the consent decree technology at Mesa Verde National Park (Mesa Verde). The installation of WESP would result in a facility-wide improvement of 0.62 dv at Mesa Verde. Improvements on a unit-by-unit basis at all Class I areas showed very minor improvements, usually less than 0.1 dv.

What did NMED determine as BART for NO_x at SJGS?

Based on the five factor analysis, the Department has determined that BART for Units 1-4 for NO_x is SNCR technology and an emission rate of 0.23 lb/MMbtu on a 30-day rolling average. The Department's determination of BART was based on the following results of the five factor analysis:

- 1) SNCR technology is considered cost-effective at an average cost of \$3,494 dollars per ton of NO_x removed. SNCR technology will reduce the facility annual NO_x emissions by 4,900 tons.
- 2) The SNCR technology will result in additional energy impacts and non-air impacts. The SNCR technology will require a new reagent system and a reagent storage system. The Department considered these additional costs in the review of the overall cost-effectiveness of SNCR and found these costs to be reasonable.
- 3) The Department reviewed the visibility improvement that resulted from the installation of the SNCR technology. The Department determined that on a facility-wide basis the visibility improved by 0.25 dv at San Pedro, 0.22 dv at Mesa Verde, and 0.21 at Bandelier.
- 4) An emission limit of 0.23 lb NO_x/MMbtu at each of Units 1-4 equals the EPA's established presumptive limit for dry-bottom, wall-fired boilers burning sub-bituminous coal. This is the most stringent presumptive limit that may be applicable to SJGS.
- 5) The Department reviewed additional economic information provided by PNM that analyzed the economic impact to ratepayers in New Mexico. The PNM estimates indicate the cost of control technology beyond SNCR would be financially burdensome and cause economic hardship to low-income New Mexicans. According to the US Census Bureau,

1 as of 2009, 18% of New Mexicans were living below the poverty line, as defined by the
2 federal poverty standards. PNM estimates a rate increase of \$11.50 per year per
3 residential ratepayer from the installation of SNCR versus an estimated rate increase of
4 \$82.00 per year from the installation of SCR.
5

- 6 6) The Department has determined that in light of the unreasonable costs of SCR,
7 particularly as reflected in the impact on ratepayers, requiring controls to achieve
8 reductions beyond the most stringent presumptive standard prescribed by EPA is not
9 justified.
10

11 **Do the BART Guidelines Provide for Consideration of the Economic Impacts of Control**
12 **Costs?**

13 Yes. The guidelines explain that “[t]here may be unusual circumstances that justify taking into
14 consideration the conditions of the plant *and the economic effects of requiring the use of a given*
15 *control technology*. These effects would include effects on product prices, the market share, and
16 profitability of the source. Where there are such unusual circumstances that are judged to affect
17 plant operations, you may take into consideration the conditions of the plant and the economic
18 effects of requiring the use of a control technology.”¹³

19 The Department believes it is particularly appropriate to consider the effect of BART costs on
20 product prices where the product is electric power, an essential service, and where most
21 customers do not have access to a competing provider. The Department believes that economic
22 effects on ratepayers is a more compelling policy consideration than economic effects such as the
23 profitability of the source, which is a recognized factor for making a BART determination under
24 the Guidelines.

¹³ 70 Fed. Reg. at 39171.